DOCUMENT RESUME

ED 155 013 SE 024 261

AUTHOR Schwing, Carl M.
TITLE A Guide for Developing Standard Operating Job Procedures for the Sludge Thickening Process Wastewater Treatment Facility. SOJP No. 9.
INSTITUTION Charles County Community Coll., La Plata, Md.
SPONS AGENCY Environmental Protection Agency, Washington, D.C. Div. of Manpower Training.
PUB DATE May 73
GRANT EPA-900253
NOTE 45p.; For related documents, see SE 024 262-263 and SE 024 091-097; Not available in hard copy due to marginal legibility of original document

EDRS PRICE MF-$0.83 Plus Postage. HC Not Available from EDRS.
DESCRIPTORS *Guides; Industrial Training; *Instructional Materials; *Job Training; *Post Secondary Education; Safety; Technical Occupations; Utilities; *Waste Disposal; Water Pollution Control; Water Resources
IDENTIFIERS *Sludge; *Waste Water Treatment

ABSTRACT

This guide describes standard operating job procedures for the screening and grinding process of wastewater treatment facilities. The objective of this process is the removal of coarse materials from the raw waste stream for the protection of subsequent equipment and processes. The guide gives step-by-step instructions for safety inspection, startup, procedures, continuous operating procedures, and shutdown procedures. (Author/BB)

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SOJP NO 9

SLUDGE THICKENING

A GUIDE FOR THE DEVELOPMENT OF

STANDARD OPERATING JOB PROCEDURES

FOR WASTE WATER TREATMENT PLANT UNIT OPERATIONS

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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LA PLATA, MARYLAND

GRANT NO 900253
MANPOWER DEVELOPMENT STAFF,
ENVIRONMENTAL PROTECTION AGENCY.

SE 024 261

A GUIDE FOR THE DEVELOPMENT
OF
STANDARD OPERATING JOB PROCEDURES
FOR
WASTEWATER TREATMENT PLANT
UNIT OPERATIONS

BY

CHARLES COUNTY COMMUNITY COLLEGE

LA PLATA, MARYLAND

FOR

MANPOWER DEVELOPMENT STAFF

OFFICE OF WATER PROGRAMS OPERATIONS

ENVIRONMENTAL PROTECTION AGENCY

GRANT NO. 900253

MAY 1973

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A GUIDE FOR DEVELOPING

STANDARD OPERATING JOB PROCEDURES

FOR THE

SLUDGE THICKENING
PROCESS
WASTEWATER TREATMENT FACILITY

SOJP NO 9

Developed by Charles County Community College under
a grant with the

Manpower and Training Staff
Office of Water Programs Operations
Environmental Protection Agency

Standard Operating Job Procedures for the Sludge Thickening

This Process was developed by:

Name Carl M. Schwing

Address P.O. Box 517, La Plata, Maryland 20646

Position Sanitary Engineer

Education and Technical Background B.S. Chemistry, Xavier University Cincinnati, Ohio, Graudate Studies, Civil & Environmental Engineering Washington University, St. Louis. Registered Professional Engineer, Missouri; Certified Wastewater Treatment Plant Operator Class "A", Maryland

Name Thomas T. Schwing

Address P.O. Box 517, La Plata, Maryland 20646

Position Wastewater Treatment Plant Technician

Education and Technical Background Data Processing, Xavier University, Cincinnati, Ohio Wastewater Treatment Plant Operator, Howard County, Maryland

SOJP NO 9 PAGE NO 1

Process Sludge Thickening

1. Operation Objectives

2. Brief Description of Process

1. To reduce the volume of sludge to be treated in subsequent units by removal of as much water as possible.

2. Raw sludge from the primary sedimentation tanks and/or waste activated sludge from the secondary process are pumped into a circular settling tank. During the approximately 18 hours that the sludge is in this tank, the solids settle to the bottom in a concentrated mass. At the same time excess water which separates from the solids overflows the weir at the upper perifery of the tank. The overflow returns to the head of the plant by means of the plant sewer.

   Floating solids are removed from the unit by a revolving skimming arm which moves them to a scum trough and pit. The scum can be pumped to the digesters or permitted to flow to the plant sewer.

   The thickened sludge is withdrawn by a positive displacement pump located in the digester building.

   The unit can be operated according to the Torpey Process by adding approximately 8 to 12 volumes of secondary clarifier effluent or mixed liquor per volume of sludge to enhance sedimentation.

Process Sludge Thickening

General Description of Equipment Used in the Process

The sludge thickener consists of a circular tank 60 feet in diameter and 10 foot SWD. The bottom is conical with a depth of 4.5 feet. The tank is covered with a styrafoam dome to control odors and to maintain a more uniform water temperature.

Raw sludge pumped from the primary settling tanks through a six inch line enters a junction box at the edge of the thickener. Waste activated sludge from the secondary process either in the form of mixed liquor or return sludge is pumped to the junction box through a ten inch line. It is highly desirous to have dilution water in the form of plant effluent added so that the total flow to the unit is 8 to 12 times the volume of the raw primary sludge flow. Consequently final effluent may be pumped through an eight inch line to the thickener junction box.

The mixture of raw primary sludge, waste activated sludge and dilution water flows from the junction box to the center inlet section of the thickener. Thickened sludge is withdrawn from the bottom of the thickener and is pumped by either or both of two duplex plunger pumps to either the digesters or the sludge disposal building.

The excess water overflows the weirs on the periphery of the tank and flows to the plant sewer. Scum formed on the surface of the tank is removed by a circular skimming arm which moves the scum to a scum trough through which it flows to the scum vault from where it is pumped with the thickened sludge to disposal or permitted to flow to the plant sewer.

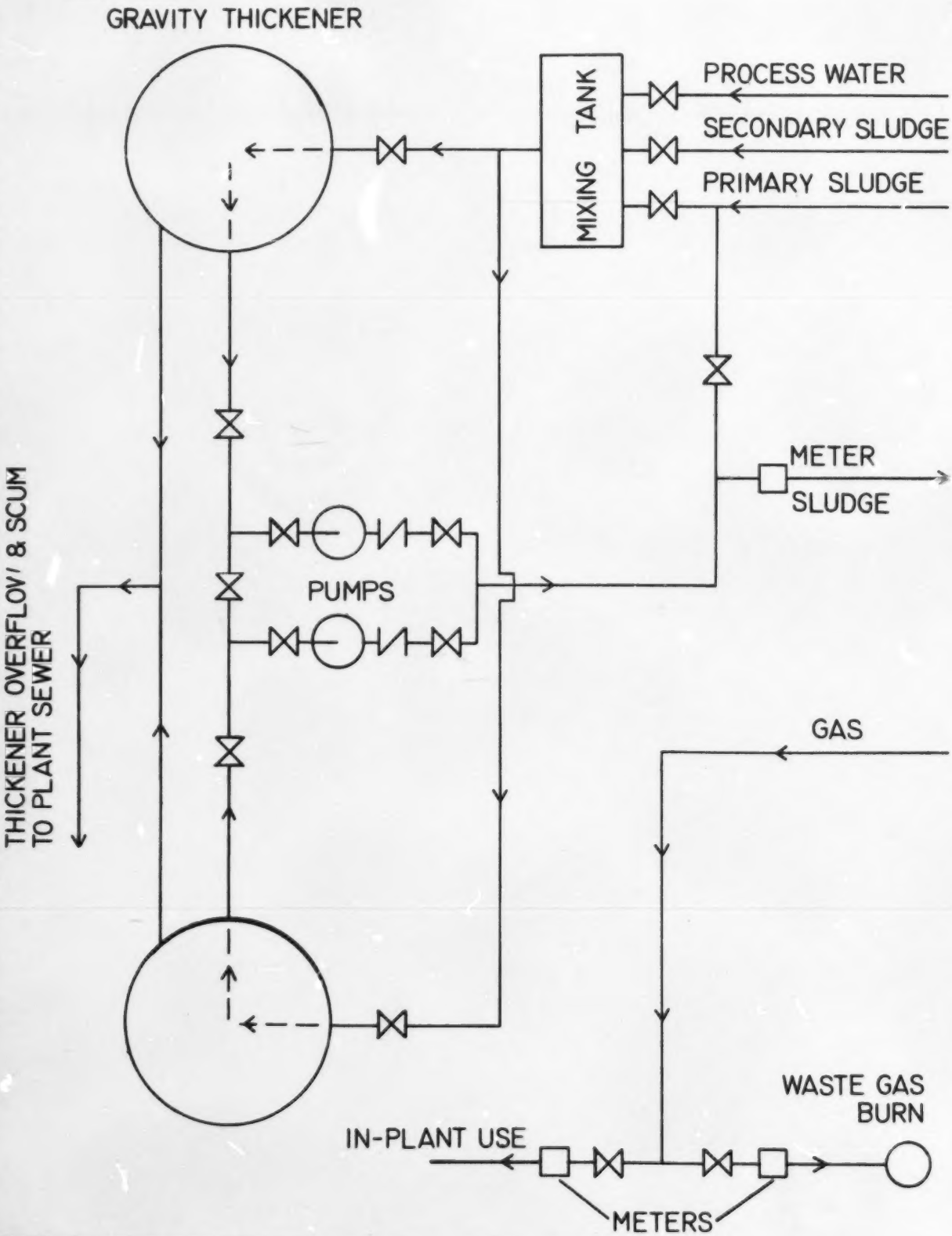
The raw primary sludge and waste activated sludge are metered at their origin. The dilution water, thickener overflow, and thickened sludge are measured by use of magnetic flow meters which have local indicators and totalizing, recording, and indicator meters at the plant's main control panel.

The plant effluent which is used as dilution water may have additional chlorine added at its source for odor control and to retard early decomposition of the sludge.

If the unit must be taken out of service for maintenance the raw primary sludge can be pumped directly to the digesters. The waste activated sludge can be returned to the primary settling tanks.

Process Sludge Thickening

Flow Sheet



STANDARD OPERATING JOB PROCEDURES

SOJP NO 9

PROCESS Sludge Thickening

Prepared by C.M. Schwing T.T. Schwing Date 4-73

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
A. PRESTART UP INSPECTION PROCEDURES			
1. Safety Inspection	1. Close all valves	1. If valve operation is not proper, stop inspection and report malfunction.	V.1
	2. Lock-out all switch gear	1. Tags should be on switch gear giving reason for lock-out.	XII.1
2. Tank and Structure Inspection	1. Inspect inlet and outlet conduits and structure for obstruction	1. Remove all foreign objects such as containers, wood scraps, welding rods, ladders, etc.	XII.2 XII.3
3. Equipment Inspection	1. Check drive unit for proper lubrication	1. Refer to manufacturer's bulletin and lubrication chart and schedule.	V.3 IX.1
4. Electrical Inspection	1. Check electrical switch gear for proper nomenclature and operation	1. Refer to equipment maintenance record for overload heaters proper size.	V.4 IX.1
	2. Unlock and activate switch gear	1. Measure voltage at all points to motor disconnect.	
	3. Check motor for proper rotation		
	4. Check drive unit for proper freedom of movement.	1. Make certain that overload protection is adequate-shear pin and limitorque switch.	V.3

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
	5. Clear tank of all personnel.		
	6. Open plant effluent valve #___		
	7. Notify operator of plant effluent section of need for plant effluent.		
	8. Fill unit with plant effluent.		
	9. Check for leaks in pipes and structure after unit has filled.	1. Repair and record all leaks.	
	10. Check overflow weirs for uniform withdrawal.	1. Adjust weirs as needed.	
	11. Check sludge withdrawal pump.	1. Refer to manufacturer's bulletin	X.5
	12. Turn on magnetic flow meters and check calibration.	1. Refer to manufacturer's bulletin	V.6 XI.1

STANDARD OPERATING JOB PROCEDURES

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
B. START-UP PROCEDURES			
1. Fill Tank	1. Notify operators of primary section, secondary section and final effluent sections that tank is going into operation.		IV.1
	2. Open raw primar sludge, waste activated sludge, and final effluent valves.		
	3. Adjust raw primary sludge flow for maximum thickness.		
	4. Adjust waste activated sludge flow to necessary wasting rate.		
	5. Adjust plant effluent flow rate so that there is a total of about 8-12 volumes of water per volume of raw sludge.		I.1
	6. Turn on collector mechanism.		

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PROCESS Sludge Thickening

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
	7. Place flow meters into operation.		
	8. When sludge blanket level reaches the selected elevation or collector drive motor current reaches the selected valve, notify the sludge digester operator and initiate thickened sludge pumping.		IV.1
	9. Open valves to selected sludge withdrawal pump.		
	10. Turn on selected sludge withdrawal pump.		

STANDARD OPERATING JOB PROCEDURES

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PROCESS Sludge Thickening

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
C. CONTINUOUS OPERATING PROCEDURES			
1. 2 Hour Inspection	1. Check drive unit for proper operation.	1. Oil level should be at proper mark. Motor should be running smooth.	
	2. Observe liquid in tank for rising sludge.	1. Excessive amounts of sludge floating to surface should be avoided. This may arise from: 1. Excessive solids loadings 2. Improper withdrawal of sludge 3. Septicity	VII.1
	3. Observe percent of overload current meter for proper operating range.	1. High current draw indicates an excessive thickening and will eventually lead to pumping difficulty and overload of the collector drive unit.	VII.1
	4. Observe the following meters for proper flow rate: 1. Raw primary sludge 2. Waste activated sludge 3. Dilution water 4. Thickener overflow 5. Thickened sludge		VII.1
	5. Grab samples and composite.		VII.1 III.1

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STANDARD OPERATING JOB PROCEDURES

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
	1. Sample the thickener overflow and composite the samples	1. Sample should be analyzed for pH, suspended solids, volatile suspended solids, and BOD.	X.1
	2. Sample the thickened sludge, composite the samples.	2. Samples should be analyzed for pH, total solids, volatile total solids, and alkalinity. If sludge is being pumped to digesters, volatile acids analyses should also be performed.	X.1
	3. At the same time that the thickened sludge sample above is taken, another sample for 15 min centrifuge test should be taken.		
	6. Withdraw sludge at a rate so as to obtain solids concentration of 7-10%.		VI.1 I.1 VII.1
	7. If the following abnormal conditions are observed take necessary corrective action:		
	1. Sludge too thick 2. Sludge too thin	1. Increase sludge withdrawal rate 2. Reduce sludge withdrawal rate. Possibly reduce dilution water flow rate.	VII.1 I.1

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
	3. Offensive odors	3. Increase dilution water flow rate and/or chlorine feed to dilution water. Possibly increase sludge withdrawal rate.	VIII.1
	4. Sludge will not settle	4. Calculate hydraulic and solids loading rates and adjust to maintain proper operating range. Evaluate the possibility of utilizing a coagulant.	II.1
	8. Observe operation of thickened sludge pump for smooth operation	1. Check packing for sealing liquid.	
		2. Check oilers for sufficient lubrication level.	XII.4
		3. Check suction and discharge gauges for proper operating range indication.	
2. Every Shift	1. Record all flow meter readings on the operating sheet		XIII.2
	2. Using depth indicator measure the depth of sludge blanket every shift	2. A rising sludge blanket level can be an indication of: 1. Inadequate thickening 2. Insufficient sludge withdrawal rate	IV.1 XIII.1
3. Weekly	Hose down the overflow trough and weir to remove debris		

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
D. SHUT DOWN PROCEDURE			
1. Tank and Equipment Shutdown	1. Shut off feed pumps to tanks. 2. Withdraw sludge until it runs thin. 3. Wash down equipment as water level drops. 4. Shut off drive mechanism and lock and tag it out. 5. Drain thin sludge and remaining water to plant sewer. 6. Shut off flow meters. 7. Complete cleaning process.		

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
E. PREVENTIVE MAINTENANCE (MAY BE DONE BY OTHERS)			
1. Routine Maintenance	1. Check level of lubricant in drive unit weekly, drain condensate if any and oil as necessary	1. See lubrication schedule for proper lubricant	XIII.1, IV.1, V.3 IX.1
	2. Lubricate gear reducer unit.	2. See lubrication schedule for proper interval and lubricant.	XIII.1 IV.1, IX.1 V.3
	3. Lubricate motor.	See 2 above	XIII.1 IV.1, IX.1 V.3
	4. Check motor electrically (semi-Annually).	Record: 1. Voltage 2. Amperage 3. Insulation resistance	IV.1, V.3 IX.1, XIII.1
	5. Check overload switch for proper operation every three months.		IV.1, V.3 IX.1, XIII.1
	6. Inspect switch gear annually.	Record Consition	IV.1, IX.1 V.4 XIII.1
	7. Calibrate flow meters.	See Manufacturers O & M Manual	IV.1, V.6

STANDARD OPERATING JOB PROCEDURES

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T.T. Schwing

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OPERATING PROCEDURES	STEP SEQUENCE	INFORMATION/OPERATING GOALS/SPECIFICATIONS	TRAINING GUIDE NOTE
	8. Dewater unit annually.	1. Check condition of submerged structure	XI.2
		2. Clean and apply protective coatings as necessary	XII.2
		3. Replace worn scraper blades	XII.3
	9. Inspect thickened sludge pump.	See Manufacturers O & M Manual	IV.1, IX.1, XIII.1, V.5

TRAINING GUIDE

SECTION	TOPIC
I	Operating Theory
II	Educational Concepts - Mathematics
III	Educational Concepts - Science
IV	Educational Concepts - Communications
V	Process Equipment
VI	Process Flow - Characterization
VII	Process Control
VIII	Abnormal Operations - Trouble Shooting
IX	Maintenance Practices
X	Laboratory Practices
XI	Instrumentation - Automation
XII	Safety Practices
XIII	Records Reports

OPERATING THEORY

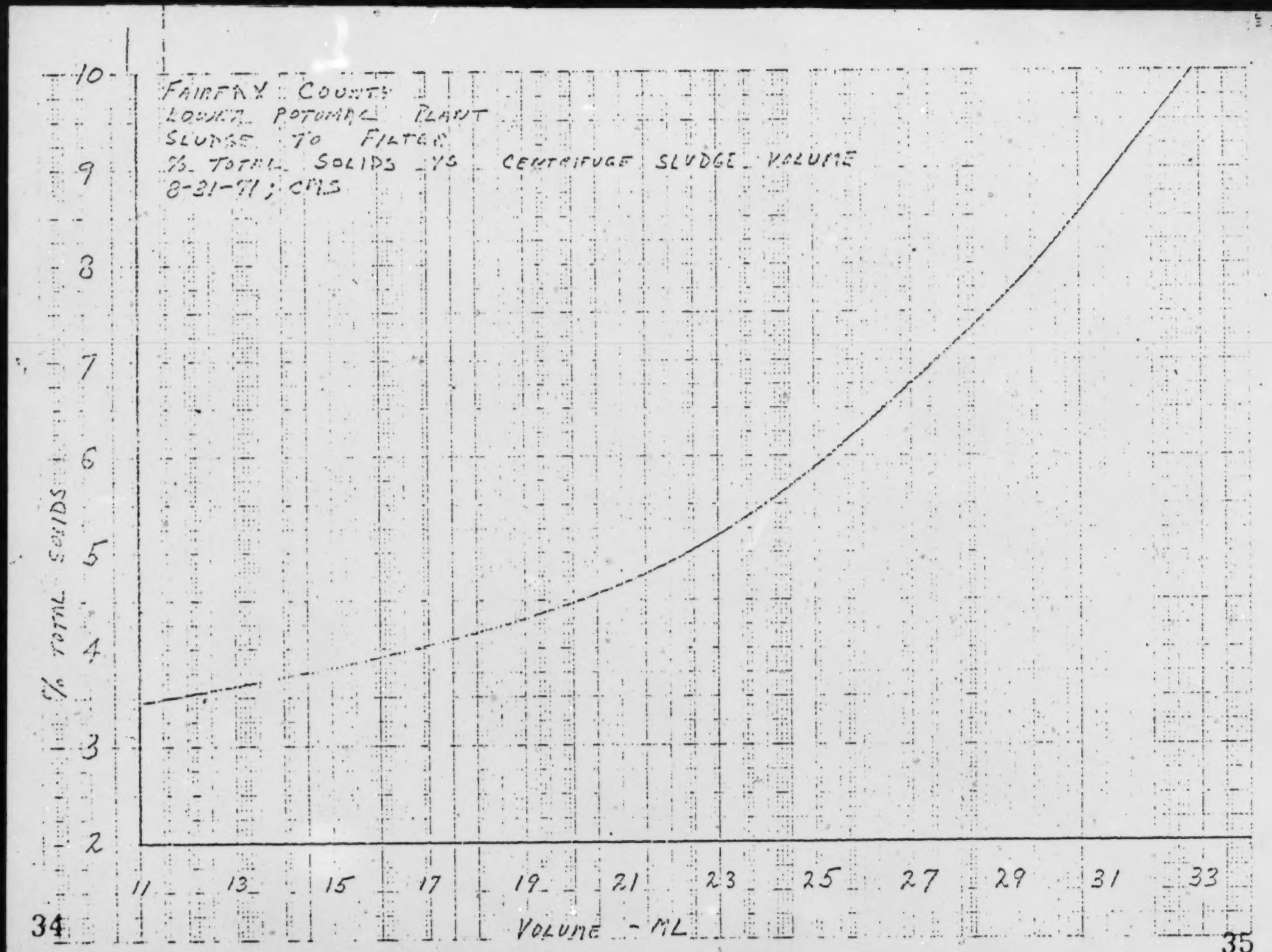
TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
I.1 (B.1.5) (C.1.6) (C.1.7)	Sludge Thickening	WPCF, MOP #14, Sec. 11.1 WPCF MOP #11, Sec. 8.1 WPCF MOP #8 Sec. 15.1 Texas Manual pp. 308-318

EDUCATIONAL CONCEPTS - MATHEMATICS

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
II.1 (C.1.7.4)	Hydraulic loading:	
	Raw Primary Sludge 54,000 GPD Waste Activated Sludge 147,000 GPD Dilution Water 539,000 GPD Total Flow 740,000 GPD	
	Solids Loading:	
	Raw Primary Sludge 13,500 #/day Waste Activated Sludge 12,250 #/day 25,750 #/day	
	Surface Area	
	$A = \pi/4\ D^2$	
	$= .785\ (60)^2 = .785\ (3600)$	
	$= 2826$ S.F.	
	Loading Rates:	
	$\text{Hydraulic} = \frac{\text{GPD}}{\text{Surface Area}} = \frac{740,000}{2826}$	
	$= 261.9$ GPD/SF	
	$\text{Solids} = \frac{\#/\text{day}}{\text{Surface Area}} = \frac{25,750\ \#/\text{day}}{2826\ \text{SF}}$	
	$= 9.11$ #/day/SF	
	Detention Time:	
	$T = \frac{V}{Q} = \frac{(A \times H \text{ cylinder}) + (1/3\ A \times 11 \text{ cone}) \times 24 \text{ hrs/day}}{740,000 \text{ GPD}}$	
	$= \frac{(2826 \times 10) + (\frac{4.5}{3} \times 2826) \times 7.48 \text{ gal/c.f.} \times 24 \text{ hrs/day}}{}$ $= 7.9$ hrs	

EDUCATIONAL CONCEPTS - SCIENCE

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
III.1 (C.1.5)	1. Determination of pH	New York Manual pg. 132
	2. Sludge Solids Test	New York Manual pg. 134
	3. Suspended Solids Test	New York Manual pg. 135
	4. Total Solids Test	New York Manual pg. 136
	5. Biochemical Oxygen Demand Test	New York Manual pg. 139
	6. 15 minute Centrifuge Test It has been demonstrated in the past that if close control is kept over the thickening process, that a more uniform and higher concentration of solids can be achieved. Since sludge samples are normally taken to the laboratory, the results often do not come back to the operator for a considerable length of time. For this reason, it is highly desireable to have a rapid means to determine the percentage of total solids in the sludge. The centrifuge test is simple and requires a minimum of equipment. An initial curve is obtained by determining the total solids on at least 50 different sludge samples from the same process unit. On the same 50 samples 15 minute centrifuge spins are made. The curve is prepared by plotting the results of these tests as per the attached graph. To determine the total solids concentration, the operator fills two 50 ml short conical graduated centrifuge tubes with a sludge sample. An International Clinical Centrifuge, 5-101-5, equipped with a 4 place 50 milliliter centrifuge head and appropriate metal shields and trunniun rings is operated for 15 minutes at 1,000 rpm. The centrifuge is stopped and the volume of centrifugate (solids in the bottom of the tube) is observed. If for instance a volume of 20 ml is observed, the corresponding total solids would be 4.5% on a dry weight basis according to the attached chart.	


FAIRFAX COUNTY
LOWER POTOMAC PLANT
SLUDGE TO FILTER
% TOTAL SOLIDS VS CENTRIFUGE SLUDGE VOLUME
8-21-71; CPLS
% TOTAL SOLIDS
10
9
8
7
6
5
4
3
2
11
13
15
17
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VOLUME - ML

EDUCATIONAL CONCEPTS - COMMUNICATIONS

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
IV.1 (B.1.1) (B.1.8) (E.1.1.9) (B.2.2.1)	1. Plant Daily Operating Sheet - Section 9 2. Maintenance Report (Trouble) 3. Preventive Maintenance File Cards 4. Equipment Inventory Cards 5. Foreman's Daily Report 6. Plant Operating Log	

PROCESS EQUIPMENT

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
VI (A.1.1.1)	Valves	Equipment Manufacturer O & M Manual
V.2 (A.2.1.1)	Thickener Structure	Plant Blue Prints and Shop Drawings
V.3 (A.3.1.1) (A4.4.1) (E.1.1-5)	Drive Unit	Shop Drawings and Manufacturers Bulletin
V.4 (A.4.1.1) (E.1.6)	Electrical Switch Gear	Plant Drawings, Shop Drawings, Manufacturers Bulletins
V.5 (A.4.11.1) (E.1.9)	Thickened Sludge Pumps	Shop Drawings and Manufacturers Bulletins
V.6 (A.4.12.1) (B.1.7) (E.1.7.1)	Flow Meter	Shop Drawings and Manufacturers Bulletins

PROCESS FLOW - CHARACTERIZATION

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
VI.1 (C.1.6)	The thickened sludge should be uniform in consistency and should have no layers of liquid formed when a sample is permitted to set for several hours. The thickened sludge should be 7-10% total solids; if the solids concentrate to greater than 10%, difficulty in pumping the thickened sludge may be aniticpated. The overflow should be low in solids, no greater than 5000 mg/l; if the overflow is greater than this value, other treatment plant processes may be overloaded.	

PROCESS CONTROL

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
VII.1 (C.1.2-7)	By careful observation of the unit process and performing the 15 minute centrifuge test at 2 hour intervals, good process control can be achieved with a minimum of effort.	

ABNORMAL OPERATIONS - TROUBLE SHOOTING

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
VIII.1 (C.1.7.1-4)	Poor quality sludge usually arises from not adjusting the flow to the thickener properly at accepted intervals of time, or not adjusting the rate of sludge withdrawal. Offensive odors can be a serious problem with this unit especially on hot summer evenings when the humidity is high and there is no air movement. Increasing the chlorine feed rate can assist in solving this problem. In some cases it may be necessary to construct a Styrofoam cover over the unit and feed the vapor over the unit through an air pollution control device. If this cannot be done, it may be necessary to take the unit out of service.	

MAINTENANCE PRACTICES

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
IX.1 (A.3.1.1) (A.4.1.1) (E.1.1-9)	1. Organization and Administration of the Maintenance Forces	Morrow, Sec. 1
	2. Planning and Scheduling Maintenance Works	Morrow, Sec. 3
	3. Costs and Budgets for Maintenance Operation	Morrow, Sec. 5
	4. Maintenance of Electrical Equipment	Morrow, Sec. 7
	5. Maintenance of Mechanical Equipment	Morrow, Sec. 8
	6. Maintenance of Service Equipment	Morrow, Sec. 9
	7. Lubricants and Lubrication	Morrow, Sec. 12
	Morrow, L.C., Maintenance Engineering Handbook, McGraw-Hill, New York, 1966, 2nd edition.	

LABORATORY PRACTICES

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
X.1 (C.1.5.1) (C.1.5.2)	Since the flow to the thickeners is relatively constant, 100 ml of sludge should be collected at each sampling time. These samples should be placed in a half gallon jar which is clearly marked with the sample source and date. The samples should be kept refrigerated until delivered to the laboratory, which is usually at a set time each day.	

INSTRUMENTATION - AUTOMATION

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
XI.1 (A.4.12.1)	Instruments and Instrumentation	Morrow, Sec. 13
XI.2 (E.1.7)	Instrumentation and Control in Water Supply and Wastewater Proposal by Russell H. Babcock, P.E., Reuben H. Donnelby, Corp.	

SAFETY PRACTICES

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES	REFERENCES/INSTRUCTIONAL RESOURCES
XII.1 (A.1.2.1)	Make certain circuits are "Dead" and locked and tagged out to prevent electrical shock.	
XII.2 (A.2.1.1) (E.1.8)	Use care setting ladders in tanks with inclined bottoms to prevent falls.	
XII.3 (A.2.1.1) (E.1.8)	Use care when walking on inclined bottoms to prevent falls.	
XII.4 (C.1.8.2)	Do not add oil to pump oilers while pump is in operation.	

RECORDS - REPORTS

TRAINING GUIDE NOTE	TRAINING INFO: THEORY/CONCEPTS/CALCULATIONS/ TECHNIQUES		REFERENCES/INSTRUCTIONAL RESOURCES
XIII.1	Plant Daily Operating Sheet		
(C.2.1)	1. Raw primary sludge thickener	Gallons	
(C.2.2.1)	2. Waste activated sludge to thickener	Gallons	
(E.1.1-9)	3. Dilution water to thickener	Gallons	
	4. Thickener overflow	Gallons	
	5. Thickened sludge pumped	Gallons	
	6. Sludge blanket depth	Feet	
	7. Chlorine added	PPD	
	8. Chlorine dosage	MG/L	
	9. Elapsed time		
	a. Thickener drive mechanism	Hours	
	b. Thickened sludge pump	Hours	